Damage Adaptation Using Integrated Structural, Propulsion, and Aerodynamic Control, Phase I

Completed Technology Project (2007 - 2007)

Project Introduction

The proposed SBIR Phase I plan of research seeks to develop and demonstrate an integrated architecture designed to compensate for combined propulsion, airframe, effector, and structural damage caused by catastrophic system failure or an intentionally hostile act. Whereas prior damage-adaptive control work focused on reconfiguring from unforeseen aerodynamic changes (e.g., effector or airframe damage), the proposed damage-adaptive control approach also accounts for the current health of the propulsion systems and key structural elements. The integrated controller merges available system identification and diagnostic information to compute a new "safe" operating envelope for the vehicle that accounts for identified changes in structural integrity/dynamics. Once this envelope is computed, the controller then proceeds to compute (1) an achievable flight path for landing the aircraft, and (2) a set of inceptor (or effector) and propulsion commands that will track the computed achievable reference trajectory in a decoupled way all the while assuring that, if physically possible, the aircraft will not excite dangerous structural modes or create structural loads that would risk further damage. The research will also investigate advisory and retrofit implementations of the proposed approach that will enable early V&V and implementation.

Anticipated Benefits

The immediate Non-NASA application is algorithms, software, and tools for the civil aviation industry. Additionally, the technology is well suited for high-level autonomous operations of unmanned vehicles (air and otherwise). The proposer has an excellent track record transitioning algorithms of this nature for industry for use in commercial and defense-related applications. The technology directly addresses the IRAC element of the NASA Aviation Safety Program. Additionally, by integrating structural health monitoring with inner- and outer-loop control, the approaches developed here would also be suitable for life extending control (i.e., using effector redundancy to minimize wear on key structural elements). Finally, the technology is directly applicable to NASA's space exploration mission in that it provides trajectory generation and control algorithms that are capable of compensating for unforeseen failures or massive uncertainties in atmospheric conditions.

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Table of Contents

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

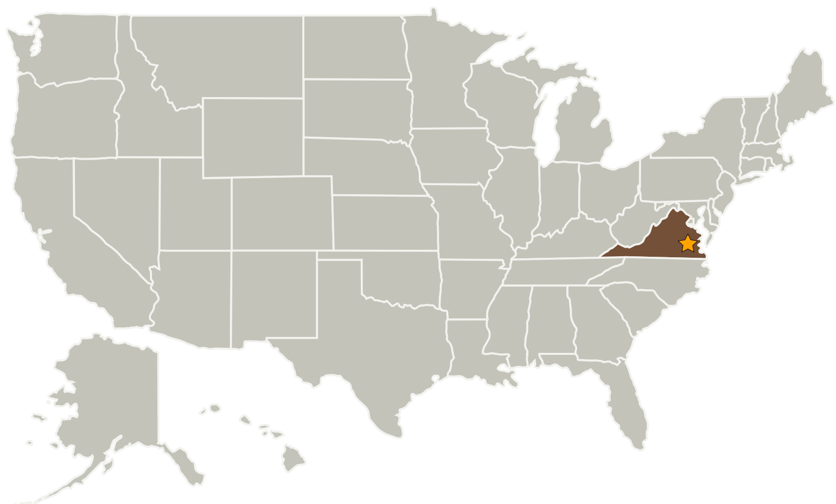
Lead Center / Facility:

Langley Research Center (LaRC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia
Barron Associates, Inc.	Supporting Organization	Industry	Charlottesville, Virginia

Primary U.S. Work Locations
Virginia

Project Management

Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Project Manager:
Irene M Gregory

Principal Investigator:
David Ward

Technology Areas

Primary:

- TX10 Autonomous Systems
  - └ TX10.2 Reasoning and Acting
    - └ TX10.2.6 Fault Response